Signal Processing in Uncooled Thermal Imager

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ABSTRACT

Thermal imaging technology has wide applications in different areas like surveillance, medical etc. This paper briefs the different signal processing techniques used in uncooled thermal imager based on Vox Micro Bolometer.

Keywords: CDS, Histogram equalization, non-uniformity, two-point correction.

1. INTRODUCTION

Infrared video systems have being widely adopted for use in military, security and civilian applications. Due to the physical limitations of the detectors, video signals obtained directly from infrared video systems are not of a high quality. Under some conditions, the images cannot be viewed or processed. For many applications the search for a means of improving video quality has become a key issue for those involved with infrared sensors and devices. The different techniques for improving the video quality from the detectors are discussed below particularly in uncooled IRFPA, using Vox micro Bolometer.

1.1 Compensation

In the detector after micro Bolometer bridge the amplifier's gain will be very high (order of above 300). Due to this, even small imbalances in the bridge causes the output to the top rail saturation or bottom rail saturation. Hence there is a need for compensation for the amplifier output. This is done in two stages basically course and fine stages. Co-efficients are supplied in binary format to get the output equal for all pixels when the FPA is illuminated with a uniform radiation. The uniform radiation is achieved by simply closing the detector with a shutter, which acts as a uniform black body.

1.2 Correlated Double Sampling

The ROIC amplifiers have an offset and low frequency noise that will be added to the video signal. To overcome this the CDS (Correlated Double Sampling) technique is used. In this technique before the pixel value is read, the amplifiers are connected to a reference node (these are not illuminated to the original scene) and this value is measured and stored. Then the amplifiers are connected to the illuminated pixel and the difference between this to the value with reference node is taken as the output.

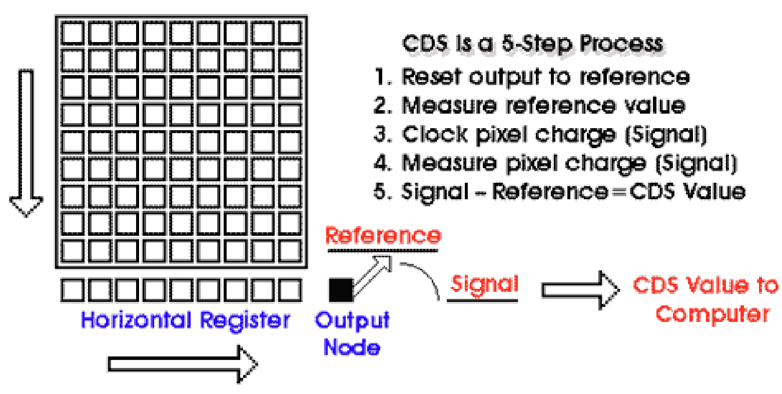

Fig. 1. CDS implementation technique

So, the generic formula for CDS correction is :

(Net Value) i=(Pixel) i- (CDS) i where i=index of the pixel and (CDS) i is the correction value calculated for that amplifier 'i'.

1.3 Two Point Non Uniformity Correction

Non-uniformity, defined as the disaccord of pixel output from within focal plane array under conditions of uniform radiation is called inherent space noise. Many factors cause the non-uniformity of infrared image. In order to solve this problem two technical methods can be used. The first is to improve the manufacture level of the detector, which is a simple solution but requires huge investment. The second method is to use modern signal processing technology to correct the non-uniformity in real time.

The two-point correction algorithm is based on reference radiant point. Figure: 2 show the principle of two-point correction algorithm.

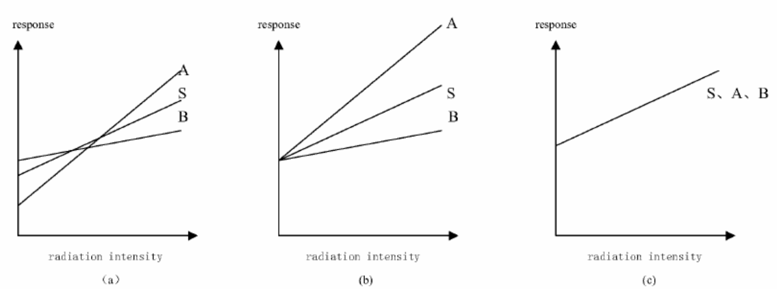

Fig. 2. The principle of two-point correction algorithm

Figure: 2a shows the response curve of two pixels with different radiations. The purpose of the non-uniformity correction is to make curve A and curve B in superposition. Creating a standard curve 'S' does it. By moving curve A and curve B, we get Figure: 2b. Then curve S is taken as standard and curve A and curve B are rotated to get Figure: 1c, which shows three curves in superposition. The method of two-point correction is as follows.

Select two radiation intensity $\phi1$ and $\phi2$ as a fixed point. Under the radiation intensity $\phi1$, measure the response of N pixels from the detector and get V_i ($\phi1$). Under the radiation intensity $\phi2$, measure the response of N pixels from the detector and get V_i ($\phi2$).

Using $V(\phi1)=\Sigma(V_i(\phi1))/N$, i=1 to N to get the average value of V_i ($\phi1$) and V_i ($\phi2$) i.e. V ($\phi1$) and V ($\phi2$).

Calculating the index of each pixel, we get $V(\phi1)=k_i V_i(\phi1)+b_i$, $V(\phi2)=k_i V_i(\phi2)+b_i$. From these equations we can find the k_i and b_i for all the pixels. According to these correction indexes, non-uniform correction in real time becomes $V_i'(\phi)=k_i X V_i(\phi)+b_i$.

1.4 Case gain correction

As the ambient temperature varies the case temperature of the detector also varies. This variation causes the pixel response to vary. Due to this the video output will not be proper. To correct this, case gain correction technique is employed. By this case gain correction we can compensate the ambient related RNU deterioration. This case gain correction is employed at camera level while maintaining uniform target temperature. The ambient temperature is varied in an environmental chamber. After collecting the data at two different ambient temperatures the case gain and offset values are calculated for the whole FPA and pixel output is corrected using these values.

1.5 Bad Pixel Replacement

Due to the manufacturing defects some of the pixels in the detector are bad and no video output is available from these pixels. These pixels appear as a black or white depending on the video polarity on the video. To compensate this bad pixels are to be replaced with some signal. This is achieved by taking the average of the surrounding pixels and displays this value at the place of bad pixel. The detector manufacturer will provide the bad pixel information.

1.6 Histogram equalization

The digitized image captured from the detector spans a much larger range of levels than the typical values available for display. Due to this the contrast will be poor. To improve the local contrast the histogram equalization technique is used. In this process the integrated frame is equalized with Cumulative Distribution Function (CDF) of previous captured frame's histogram. By this method the contrast of the image is enhanced.

2. CONCLUSION

In the above different signal processing techniques employed in uncooled thermal imager is briefed for display of good image on the display.

REFERENCES

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